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IS 2742-3 (1994): Automotive vehicles - Brake linings, Part 3: Methods of test [TED 4: Automotive Braking Systems]



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IS 2742 (Part 3) : 1994

भारतीय मानक
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REAFFIRMED

भाग 3 परीक्षण पद्धति

Indian Standard

AUTOMOTIVE VEHICLES — BRAKE LININGS

PART 3 METHODS OF TEST

UDC 629 113-597'6 : 620'1

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Braking Systems Sectional Committee had been approved by the Transport Engineering Division Council.

The requirements laid down in this standard are intended as general quality control parameters on brake linings, both for inplant control by the lining manufacturers and for quality assessment of linings by the purchasers.

This (Part 3) is one of the many parts of IS 2742 series of standards on brake linings and their test methods. The other parts are:

- 2742 (Part 1) : 1994 Automotive vehicles — Brake linings (non rubberised) : Part 1 Specification (*first revision*)
- 2742 (Part 2) : 1994 Automotive vehicles — Brake linings (rubberised) : Part 2 Specification
- 2742 (Part 4) : 1994 Automotive vehicles — Brake linings : Part 4 Coefficient of friction — Method of test
- 2742 (Part 5) : 1994 Automotive vehicles — Brake linings : Part 5 Internal shear strength — Method of test

In the preparation of this standard assistance has been derived from the following:

BSAU 142 : 1968 Methods of Tests for Brake Linings Materials.

SAE J 160 Jun 80 Swell, Growth and Dimensional Stability of Brake Linings.

The committee responsible for the preparation of this standard is given in Annex A.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

**AMENDMENT NO. 1 SEPTEMBER 1997
TO
IS 2742 (PART 3) : 1994 AUTOMOTIVE VEHICLES —
BRAKE LININGS**

PART 3 METHODS OF TEST

(*Page 3, clause 5.4.1*) — Insert the following sentence at the end of the clause:

‘The ambient temperature of the environment, where test is conducted, shall not exceed 40°C.’

(*Page 3, clause 5.4.3, last sentence*) — Substitute the following for the existing sentence:

‘If a specimen tested on the 25 mm support length fails to break when the load reaches 2 250 N, a new specimen shall be taken and tested on the 100 mm support length.’

(TED 4)

Indian Standard

AUTOMOTIVE VEHICLES — BRAKE LININGS

PART 3 METHODS OF TEST

1 SCOPE

1.1 This standard (Part 3) covers the methods of test to determine the physical and chemical properties of brake linings.

1.2 The method of test for determination of co-efficient of friction and assessment of wear is covered in Part 4 of this standard.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
170 : 1986	Acetone (<i>third revision</i>)
2500 (Part 1) : 1992	Sampling inspection procedures : Part 1 Attribute sampling plans indexed by acceptable quality level (AQL) for lot by lot inspection (<i>second revision</i>)
2742 (Part 1) : 1994	Automotive vehicles — Brake linings (Non-rubberised) : Part 1 Specification (<i>first revision</i>)
2742 (Part 4) : 1994	Automotive vehicles — Brake linings : Part 4 Co-efficient of friction — Method of test
2742 (Part 5) : 1994	Automotive vehicles — Brake linings : Part 5 Internal shear strength — Method of test
3804 : 1988	Method for calibration of Rockwell (Scales A-B-C-D-E-F-G-H-K) (<i>first revision</i>)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Sample

A selection of brake lining from any batch or delivery. The number of samples from a lot shall be as agreed to between the purchaser and the manufacturer.

3.2 Specimen

Sample or that part of a sample brake lining on which tests shall be carried out.

4 GENERAL REQUIREMENTS

4.1 The brake linings shall be free from cracks, pinholes and embedded foreign materials or any other physical defects which can be detected by thorough visual inspection. The linings shall comply with the dimensions specified by the manufacturer.

4.2 Prior to the testing of the brake lining, the manufacturer shall supply all relevant technical information.

4.3 The brake linings shall be type approved after carrying out brake performance tests of the vehicle to the relevant Indian Standards. It is accepted that the actual values of the various parameters shall be finalized only after tests on trial production batches and shall be agreed between the supplier and the purchaser for each approved type of lining. The friction values in the specification are for quality control purposes only and they do not represent the actual co-efficient of friction values between the drum and the linings.

5 TESTS

The following tests shall be carried out to determine the properties of the linings:

- a) Specific gravity;
- b) Rockwell hardness;
- c) Shore hardness;
- d) Cross breaking strength;
- e) Acetone extract;
- f) Water swell;
- g) Loss of weight on ignition;
- h) Heat swell;
- j) Friction co-efficient (Normal and Hot) [see IS 2742 (Part 4) : 1994]; and
- k) Internal shear strength [see IS 2742 (Part 5) : 1994].

NOTE — Any other test as agreed between manufacturer and purchaser may also be carried out.

5.1 Specific Gravity

The specific gravity shall be determined as specified in 5.1.1.

5.1.1 Suspend the specimen from a balance pan hook by means of a thin thread and determine the weight of the specimen in air within an accuracy of 0.1 grams.

5.1.2 Immerse the specimen in water at the ambient temperature in such a way that it is freely suspended and does not touch the surface of the water or the walls of the water container, and re-weigh within an accuracy of 0.1 grams.

5.1.3 If the weight of the thread is less than 0.05 percent compared to the weight of the specimen, its weight need not be considered for the test.

5.1.4 In weighing the specimen in water, air bubbles adhering to the specimen shall be removed. Their removal can be facilitated by the presence of a trace (example one part in 10 000) of detergent in the water, or by dipping the specimen momentarily into industrial methylated spirit, provided that it is known that the material is not affected by this treatment. If the latter procedure is adopted, care shall be taken that the minimum amount of spirit is transferred to the water in which the specimen is weighed.

The specimen shall be weighed as quickly as possible, within three minutes after immersing in water.

The specific gravity of the specimen shall be computed as follows:

$$\text{Specific Gravity} = \left[\frac{W_a}{W_a - W_b} \right]$$

where

W_a = weight in air in grams

W_b = weight in water in grams

5.2 Rockwell Hardness

5.2.1 This test shall be carried out with a Rockwell hardness testing machine. Rockwell hardness is defined in terms of the depth of penetration of a spherical indenter into the specimen.

5.2.2 The ball shall be applied to the working surface of the specimen. If necessary, a small amount of material may be removed from the surface by grinding to provide a smooth surface for the test, but the specimen shall be either flat or curved provided that it is firmly held in position, with the working surface normal to the direction of application of the load and with adequate support from below. Test to be carried out at ambient temperature.

5.2.2.1 The machine shall be capable of applying loads 100, 600, 1 000 and 1 500 N by utilizing balls of 3.175 mm, 6.35 mm and 12.7 mm

diameter and of indicating the depth of penetration of the indenter in units of 0.002 mm. A direct reading Rockwell hardness testing machine, verified in accordance with IS 3804 : 1988 shall be used for this test.

A preliminary load of 100 N shall be applied and the depth measuring device set to 30 HB (reading on the Rockwell B scale for the direct reading machine) after 10 seconds. An additional load, in accordance with the scale used, shall be applied for a period of 15 seconds and then removed. The Rockwell hardness number shall be read directly from the scale of the direct reading machine five seconds after the removal of the additional load and with the preliminary load still applied. If a direct reading machine is not available the depth of penetration (e) shall be considered five seconds after the removal of the major load and with the minor load still applied.

The Rockwell hardness = $(130 - e)$

where,

e = observed depth of penetration in units of 0.002 mm.

The hardness value for each specimen shall be taken as the arithmetic mean of the readings from at least three indentations. The indentations shall be not less than 12 mm from any edge and uniformly spaced along the specimen, if the width of the lining is less than 24 mm, the hardness shall be measured at the centre of lining.

The load and indenter size shall be chosen from the following scales:

Scale	Ball Diameter mm	Load N
R	12.7	600
L	6.35	600
M	6.35	1 000
P	6.35	1 500
K	3.175	1 500

The choice of scale shall depend on the hardness of the specimen and shall, where possible, be such that the Rockwell hardness number lies between 40 and 90 units. Scale R shall be used for soft materials with a reading less than 40 units and K for the hardest materials. In cases where a material can be tested on two scales within the limitation, the one selected shall be that giving the smaller numerical values of hardness.

It is essential always to use the same scale for any particular material. In case the above scale is not suitable for any particular material, the

manufacturer may choose an alternative scale mutually agreement with the purchaser.

5.3 Shore Hardness

This property is applicable for rubber based soft moulded linings.

5.3.1 Equipment

A Shore (D) Durometer shall be used.

5.3.2 Test Procedure

Obtain a representative specimen of thickness 6.5 mm (specimen may be piled to obtain the thickness). The specimen shall be placed on a firm hard surface. Apply the durometer in a vertical position with its foot parallel to the surface of the specimen. Lower the instrument as rapidly as possible, but without shock, exerting only sufficient pressure to ensure firm contact of the foot against the specimen. The test shall be carried out at least 12 mm away from any of the edges and at three equidistant points along the length of the specimen. If the width of the lining is less than 24 mm, the hardness shall be measured at the centre of lining. The hardness values shall be reported as the mean of three readings.

5.4 Cross breaking Strength

5.4.1 This test is to determine the ultimate stress, due to bending of a specimen with a rectangular cross section which is regular throughout the supporting length. The width of the specimen shall not be less than 10 mm and shall be uniform throughout the gauge length with a tolerance of ± 0.25 mm. In the case of linings exceeding 50 mm width, a specimen 50 mm wide shall be cut from the centre of the lining and the cross-breaking strength measured across the specimen.

5.4.2 The mean width and mean thickness of the specimen shall be determined by at least three measurements across the lining. The specimen shall be placed with the concave surface upwards, symmetrically across two parallel supports with 3.2 ± 0.125 mm radius supporting edges. The length of the supports shall be at least the width of the specimen.

5.4.3 For specimens up to and including 6.5 mm thickness, the supports shall be set 25 ± 0.25 mm apart. For specimens of greater thickness than this, the supporting length shall be 100 ± 0.25 mm. If a specimen tested on the 25 mm support length fails to break when the load reaches 2 250 N, a new specimen shall be taken and tested on the 150 mm support length.

5.4.4 The load shall be applied squarely across the width of the specimen by means of a third

block, with 3.175 ± 0.125 mm radius bearing edge, which is parallel to and mid-way between the supporting blocks. The load shall be increased steadily so that the specimen fractures in 5 to 15 seconds. The load in newtons at failure shall be noted.

Any tests in which the fracture occurs at rivet holes shall be disregarded.

5.4.5 The cross breaking strength of the specimen shall be computed as follows:

$$\text{Cross breaking strength} = \frac{150 WL}{BD^2} \text{ (N/cm}^2 \text{)}$$

where

W = load at failure in Newtons

L = gauge length in mm

B = mean width of specimen in mm

D = mean thickness of specimen in mm

Three tests are recommended, two tests at each supporting distance ends and one in the centre. Each result shall be recorded.

5.5 Acetone Extract

5.5.1 Method specified below shall be followed by which the specimen is extracted by acetone and the extract is isolated and weighed.

5.5.2 A soxhlet extraction apparatus comprising of an extractor and a suitable flask and condenser, all connected with ground glass joints shall be used.

5.5.3 The acetone used in the extraction shall comply with IS 170 : 1986.

5.5.4 A specimen of fine particles of the friction material shall be prepared by drilling with a 10 mm drill, using conditions which do not produce perceptible overheating. The samples shall be drilled perpendicular to the working face, but not nearer than 6 mm from the edges. The depth of drilling shall be such as to obtain a representative sample of the friction material, uncontaminated with any separate backing layer shall be present.

5.5.5 The weight of drillings required for the specimen is 2 ± 0.2 g and sufficient holes shall be drilled to give this weight. It is not advisable to drill a much larger size hole and to take a part of drillings for the required specimen. The time between drilling the specimen and extracting shall not exceed 4 hours.

5.5.6 The specimen shall be weighed to an accuracy of 0.001 g, and shall be wrapped securely in a filter paper. The wrapped specimen shall be placed in an extraction thimble (previously fat extracted) 25×80 mm

single thickness and transferred to the Soxhlet extractions. Sufficient acetone shall be added to fill the extraction unit plus a further quantity of 25 ml. Extraction shall proceed for six hours, or a shorter period by agreement between manufacturer and purchaser. The cycling rate during extraction shall be 10 to 20 cycles per hour. On completion of the extraction period the flask shall be removed at a stage when the extraction unit is nearly filled with acetone. This should leave about 15 ml of acetone in the extraction flask.

5.5.7 The contents of the flask shall be transferred to a pre-weighed vitreous silica crucible, the flask washed out with approximately five millilitres of acetone and the washing transferred to the same crucible. The crucible shall then be placed on a water bath and the acetone evaporated. Suitable precautions against accidental ignition of the acetone shall be taken. The crucible shall finally be dried for ten minutes in an oven at 80 to 85°C, and shall then be transferred to a dessicator, allowed to cool and reweighed.

$$\text{The percentage of acetone extract} = 100 \times \frac{(W_2 - W_1)}{W_1}$$

where

W_1 = weight of specimen, g

W_2 = weight of empty crucible, g

W_3 = weight of crucible plus extract. g

5.6 Water Swell Test

The blanks of size 50 mm × 25 mm shall be cut from the lining and soaked fully in water at room temperature for 30 minutes. The blanks shall be measured for thickness before and after soaking in water at five points equally spaced along the length of the blank and at the centre position across the width. The mean of these five readings shall be used to determine swell.

5.7 Loss of Weight on Ignition

5.7.1 The sample shall be prepared in the same way as for the acetone extract test. A representative sample of one gram shall be weighed accurately (to a third decimal place) in a previously ignited, cooled and weighed silica crucible (without lid). The crucible containing the sample is introduced into the muffle furnace maintained at 800 to 850°C and soaked for two hours. Then the crucible shall be removed from the furnace, cooled in a dessicator and weighed to constant weight. During ignition care shall be taken to ensure that no flying of dust occurs.

5.7.2 Percentage loss of weight on ignition is calculated from the formula given below:

$$\text{The percentage loss of weight} = 100 \times \frac{(W_2 - W_1)}{(W_3 - W_1)}$$

where

W_1 = weight of empty crucible, g

W_2 = weight of crucible + sample, g

W_3 = weight of crucible + sample (after ignition), g

5.8 Heat Swell

5.8.1 This test is designed to check the heat swell of brake linings in the laboratory under controlled conditions.

5.8.2 Obtain initial thickness readings at room temperature to the nearest 0.02 mm, measuring the specimen at not less than six points located approximately between 12 and 20 mm from the lining edge.

5.8.3 Place the unconfined specimen in an oven at room temperature. Increase oven temperature to $200 \pm 3^\circ\text{C}$. The time taken to raise the temperature shall be between 30 and 60 minutes. Allow the specimen to remain in oven for 30 to 40 minutes at $200 \pm 3^\circ\text{C}$. In case of rubberised linings the specimen shall be held between two metal bands of equal width on either side of the specimen and then subjected to this test.

5.8.3.1 The clamping arrangement shall be such that the pressure exerted is same as that used in bonding.

5.8.4 Remove the specimen from the oven and while still hot measure thickness at the same point used for obtaining initial thickness. Record increase in thickness as swell.

5.8.5 Procedural Criteria

5.8.5.1 Blisters and surface abnormalities at measured reference points and elsewhere shall be recorded.

5.8.5.2 Care shall be taken that transfer of heat to the measuring device does not affect the accuracy of the measurements.

6 ASSESSMENT OF TEST RESULTS

6.1 For determination of quality, the sampling method shall be as agreed between manufacturer and purchaser. The properties (chemical or physical) shall be identified only with a particular friction material and not with the brake or vehicle with which this material is used since the test procedure may be used for any material as a quality control check of the material.

6.2 Unless otherwise agreed to between supplier and purchaser the sampling shall be as per IS 2500 (Part 1) : 1992.

ANNEX A (Foreword)

COMMITTEE COMPOSITION

Composition of Automotive Braking System Sectional Committee, TED 4

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(Continued on page 6)

IS 2742 (Part 3) : 1994

(Continued from page 3)

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